Space Weather Technical Forecast

Issued on Saturday 14 December 2024 at 00:56 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Occasional R1/R2 radio blackouts Likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate solar activity has been observed with three M-class flares in the past 24 hours. There are up to six sunspot regions on the Earth-facing disc, with a small new unipolar region appearing to the southeast of AR3917 in the southwestern quadrant. The main changes in the period were for continued growth and spreading of the newly-numbered AR3924 in the south central disc, a continuation of the separation of the main penumbral spots in AR3920 in the north, and a tendency for the penumbral spots in AR3917 in the southwest to agglomerate, although the previously observed possible Mt Wilson delta spot in the leading group no longer discernible.

No obviously Earth-directed CMEs observed in available imagery, however this assessment is lower confidence due to the number of events in recent days and CMEs remain under review, although any impacts are felt most likely to be glancing - if present.

Solar Wind / Geomagnetic Activity: Solar winds, as reported by ACE at L1, showed an ongoing slow wind regime. Solar wind speeds were at background, 325-360km/s, with density within typical single-figures ppcc. The Interplanetary Magnetic Field (IMF), Bt, was weak and stable, peaking around 7nT, with the north-south component, Bz, varying between +5/-6nT. The phi angle was positive (away from the Sun). The net result of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels.

High energy electron flux (greater than 2MeV) observed by GOES16 showed a diurnal variation at Moderate levels, peaking at 834pfu at 13/1515UTC. The associated 24-hour fluence was below Active, and slowly declining. The 14/0000UTC observation was 2.65e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is Likely, with occasional M-class flares. There is a Slight Chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs as of the issue of this guidance.

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Slow wind conditions are expected until CH99's onset, most likely late on Day 1 or into Day 2 (14-15 December). Geomagnetic activity is expected to start mostly Quiet as a result, then rising to give a spell of Unsettled to Active conditions with a Slight Chance of G1 Minor Storm intervals. Activity and solar winds expected to ease into the new working week, returning conditions to mainly Quiet to Unsettled.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at Background, but with a Slight Chance of rising in response to any notable flares.

High energy electron flux is expected to be at mainly Moderate levels, but perhaps peaking at High, before falling later Day 1 or early Day 2 (14-15 December) due to likely inbound faster solar winds. The 24-hour fluence is expected to remain below the Active threshold.

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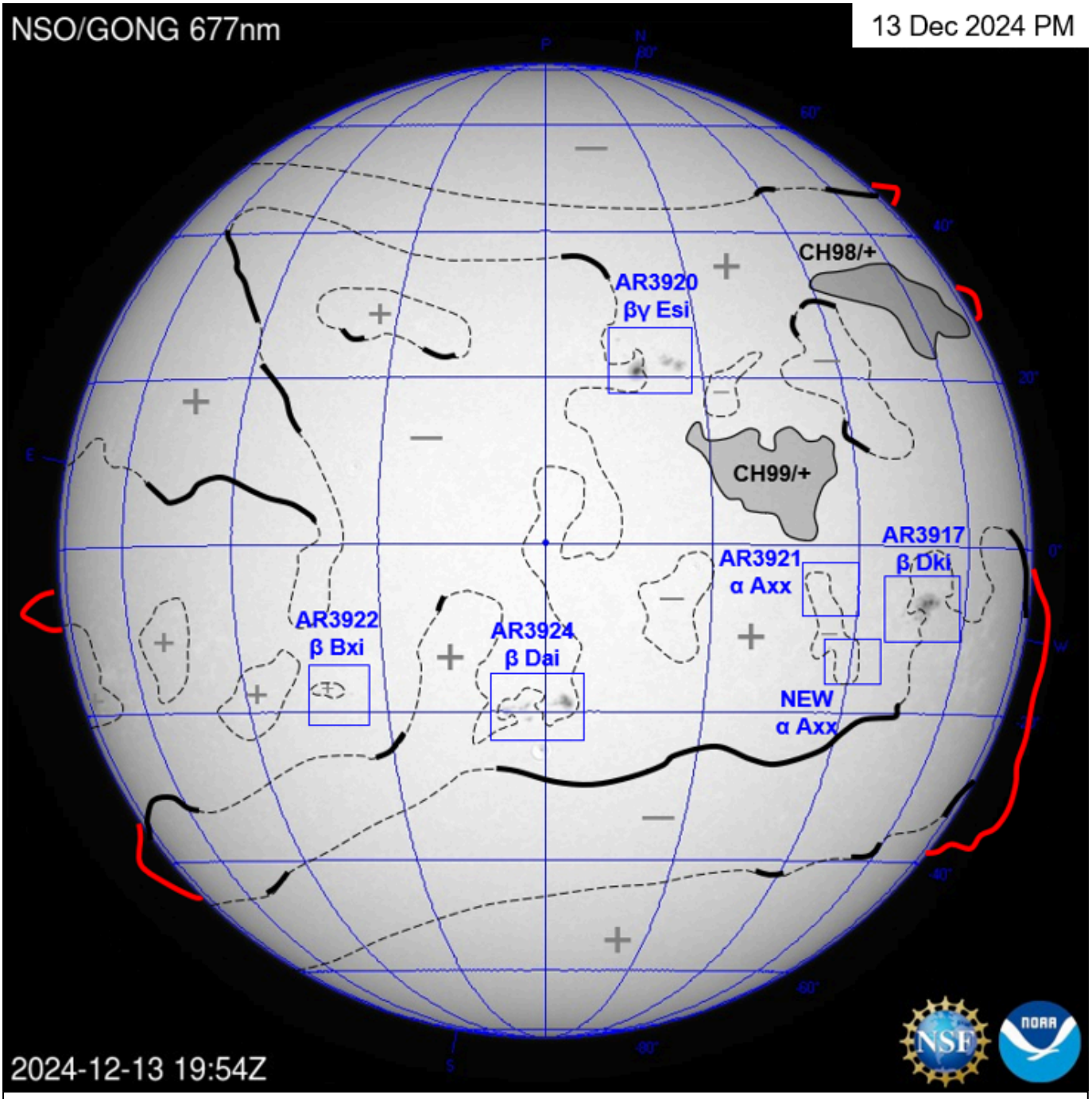
Figure 1: Solar Synoptic Map Valid 13/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no Earth-directed CMEs expected as of the time of issue, however this carries lower than average confidence due to imagery gaps and the large numbers of minor events on the disc. A number of significant filaments remain apparent of the visible disk, and continue to be closely monitored for any potential Earth-directed disruption.

The coronal hole-based forecast is relatively higher confidence. Current background slow wind conditions, and mainly Quiet geomagnetic activity are expected until the onset of the next enhancement from the fast winds of CH99+. This is a persistent feature, and was likely the cause of a weak enhancement that occurred on the previous rotation on 18 November. This resulted in winds speeds of around 450km/s, and would map to this rotation to give an arrival on Day 2 (15 December), perhaps slightly earlier if a stronger fast wind is observed. Despite the slightly elevated winds from CH99's previous rotation, there was little impact on geomagnetic activity. Activity is most likely to be in the Unsettled to Active range, before easing back into the new UTC working week.

MOSWOC ENLIL output is persisting in showing a weak enhancement on Day 1 (14 December), which is currently believed to be too quick in connecting to the HSS from CH99, but does increase confidence for a connection to be observed. This is then followed by a more notable enhancement in the model occurring on 16 Dec, which is too late to be from CH99 and has no observable source region currently on this disc. This is consequently considered anomalous and disregarded at this stage.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	15	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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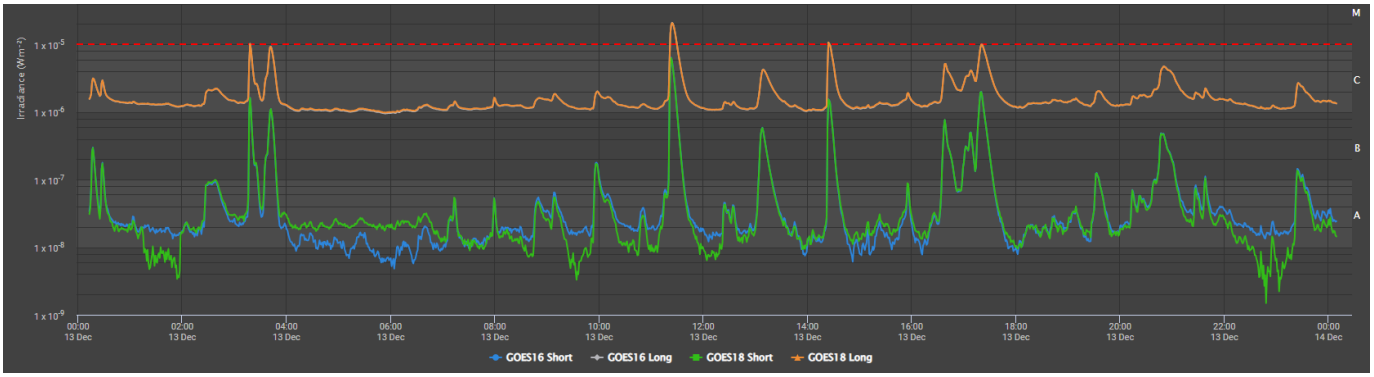
Radio Blackouts - X-Ray Flares

Moderate solar activity has been observed, with four M-class flares in the past 24 hours. AR3922's apparent simplification belying a continued trend towards jet-like emissions and lower M-class flares. The cadence of these flares has led to a revision upwards of the risks of further such flares although this risk may be reducing given the ongoing decline apparent for this region. AR3917 still remains a reasonably active region, producing isolated M-class flares, but this to showing some signs of simplification and consolidation in extent, although the increasing viewing angle rendering more detailed analysis increasingly difficult.

Regarding the evolution of sunspot regions in the four days, AR3917 will begin to cross the western solar horizon from Monday 16 December. There also continues to be the potential for further regions to rotate onto the disc from over the east limb (perhaps corresponding to Ex-AR3911 and Ex-AR3901), with some clear magnetic structure evident on e.g. GOES SUVI 171. Overall, the current flare risks is expected to ebb to nearer the raw risk for the disc over the period, with the recent spate of activity reducing, but we maintain a likelihood of occasional M-class flares with a persistent slight chance of isolated X-class flares pending further developments.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	60	55	55
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 2: Latest 24hr GOES16/18 X-Ray trace.



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux carries a daily Slight Chance of a response from any significant solar flares. Enhancement most likely from AR3917, which despite showing some signs of simplification and consolidation in extent maintains the risk of a significant flare. The decreasing component of the daily risk from this region late in the period is matches by a rising contribution from the front-side, leading to an overall roughly level trend through the four days pending further developments.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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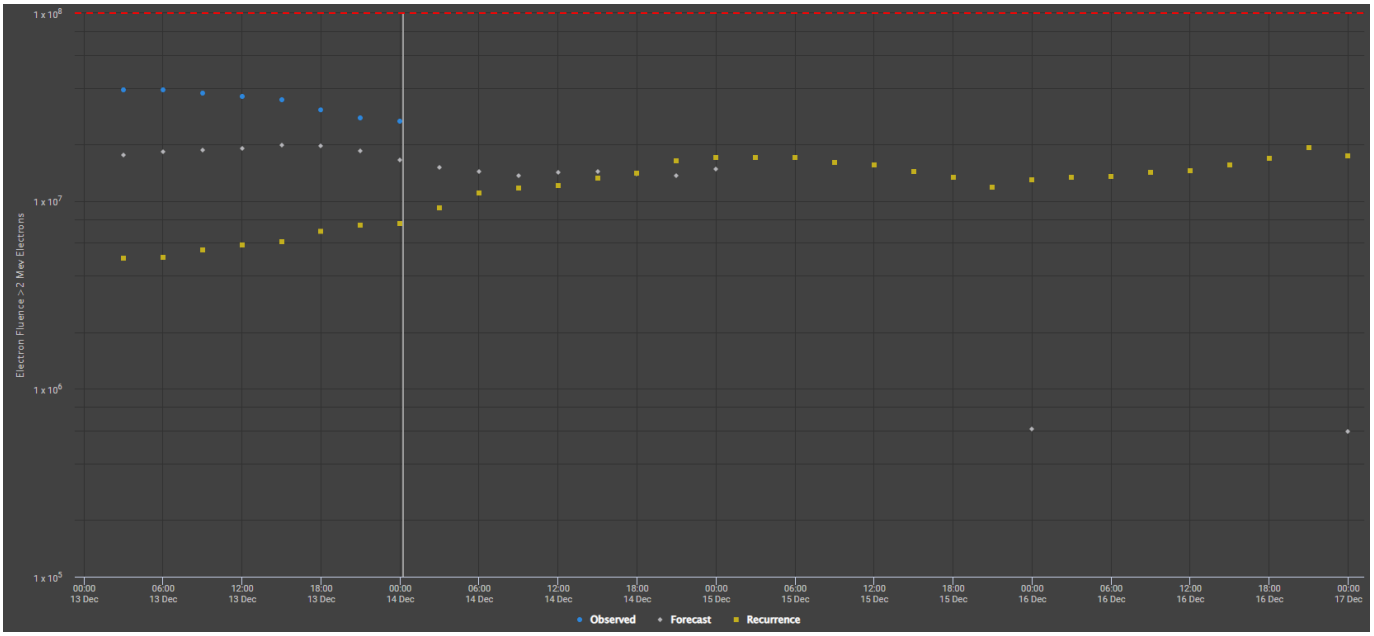
High Energy Electrons (≥ 2MeV)

High energy electron flux observed by GOES16 has been mainly Moderate, but reached High at diurnal maximum on 12 December, due to the fast wind enhancement that occurred on 9-10 December. This is expected to continue at Moderate to perhaps High level into Day 1(14 December), until the onset of any fast wind of CH99/+. This is most likely to occur late on Day 1 or early on Day 2 (14-15 Dec), with a likely dropout in observed flux as a consequence of the increased solar wind pressure. The flux is then expected to recover back to Moderate, perhaps High values as the Van Allen belts ease back to encompass GEO into Day 4 (17 December).

The associated 24-hour fluence has been rising, but appears to have peaked at around 4e7 integrated flux, still well below the Active threshold (1e8 integrated flux). This is expected to persist at around this level at first, but then ease into the period. This trend is supported by REFM, although this is underestimating current fluence values slightly. Any recovery of flux day 3-4 is currently not expected to have sufficient time to reach the Active fluence level during this period.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output.



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